# CHAPTER 3. MOSQUITO LAGOON

## Seagrass and Water Quality

### ***Seagrass Resource Assessment***

The assessment of Mosquito Lagoon's seagrass resource is based on the same three measurement indices used in the Lagoon-wide assessment:

- ❖ Acres of seagrass coverage over time (net gain or loss)
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight at the target depth of 1.7 m.

For more information on why and how these indices are used to assess seagrass resource status, refer to Chapter 2, p. 2-3.

Seagrass coverage distributions vary widely throughout the Mosquito Lagoon (Figure 3-1a and b). Major findings about seagrass coverage distribution in Mosquito Lagoon are summarized below (refer to Figure 3-1 for additional detail).

- Mosquito Lagoon, overall, has experienced little loss in seagrass coverage since 1943 (~20% loss). This favorable result is largely due to the consistently good coverage maintained in the southern reach, which is the largest reach in Mosquito Lagoon.
- The southern reach of Mosquito Lagoon (segment ML3-4) contains one of the more extensive seagrass coverages in the IRL system – approximately 732 acres per linear mile of lagoon. This reach has also experienced little change since 1943 (only 13% loss since 1943). It is located within minimally developed watersheds and comprises the federally protected bottomlands managed by the Canaveral National Seashore and U.S. Fish and Wildlife Service. However, despite its apparently stable coverage over time, the seagrass resource status in southern Mosquito Lagoon received only a fair rating based on results of the measurement indices (Table 3-1).
- The area with the least seagrass coverage in Mosquito Lagoon and with the greatest loss since 1943 is the northern reach near New Smyrna Beach (segment ML1, south of Ponce de Leon Inlet). The 1999 seagrass coverage was only 51 acres, which represents a 94% loss since 1943. Not surprisingly, the seagrass status of this reach is considered poor. Segment ML1 may have poor seagrass coverage due to physical factors such as strong current velocities and unstable sediments, in addition to light limitation, because of its proximity to Ponce de Leon Inlet and the multitude of channels and navigational cuts that characterize this segment. Whether these physical factors truly affect seagrass distribution or not in this segment is unknown and subject to investigation.

Southern Mosquito Lagoon (ML3-4) is classified as a fair or transitional area (Table 3-1); an area that is believed to be "pristine". At depths greater than1 m, light levels in Mosquito Lagoon drop significantly below the preliminary minimum light requirement for the IRL of 25% of the surface light (an annual median). Light levels at the restoration target depth of 1.7 m in Mosquito Lagoon's northern and central segments (New Smyrna to Oak Hill) generally fall well below that requirement -- 11% and 9.6% of surface light, respectively (Figure 3-1c). Southern Mosquito Lagoon is only slightly better – 15% of surface light at 1.7 m.

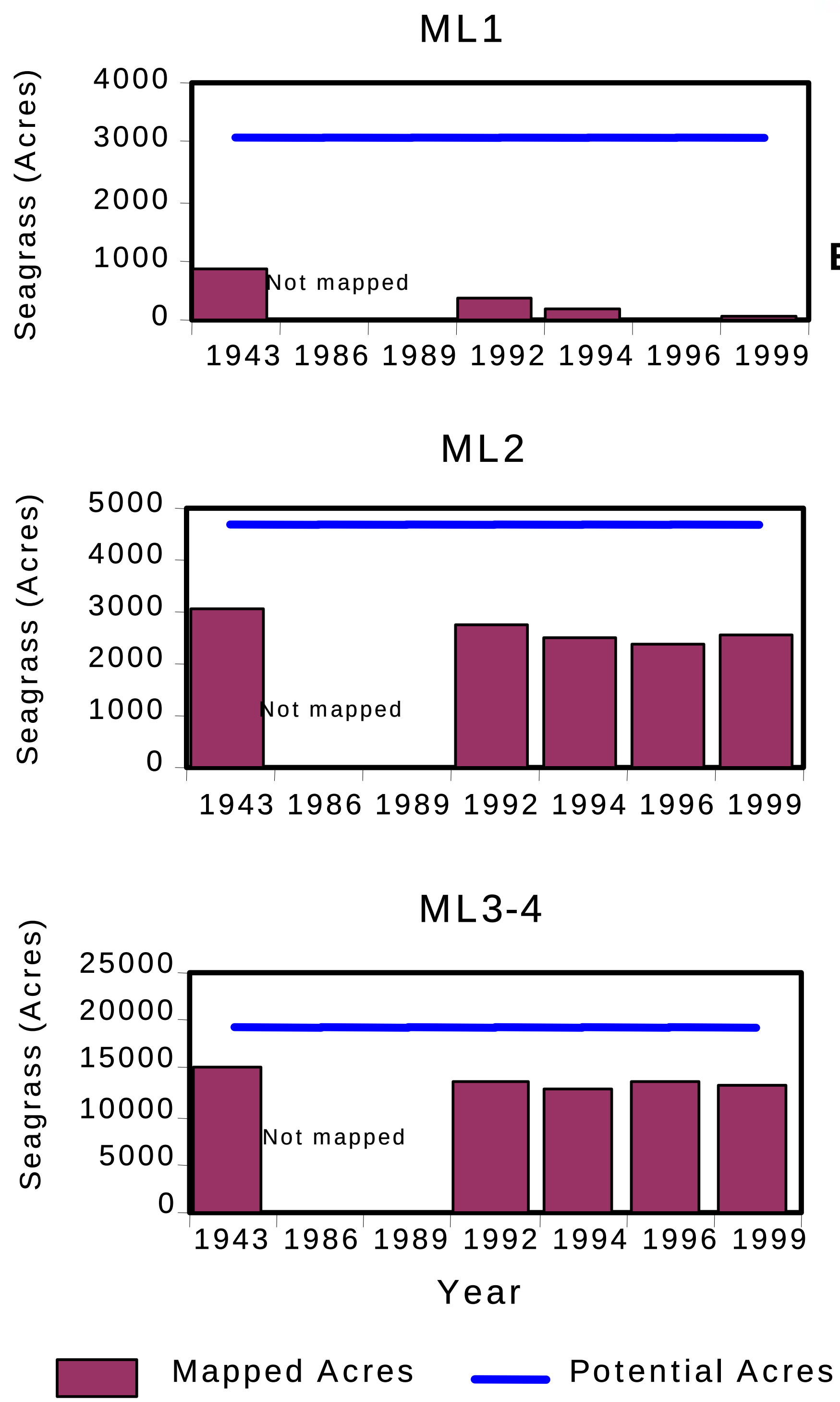



Figure 3-1b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note loss in segment ML1 and long-term stability in ML2 and especially ML3-4.

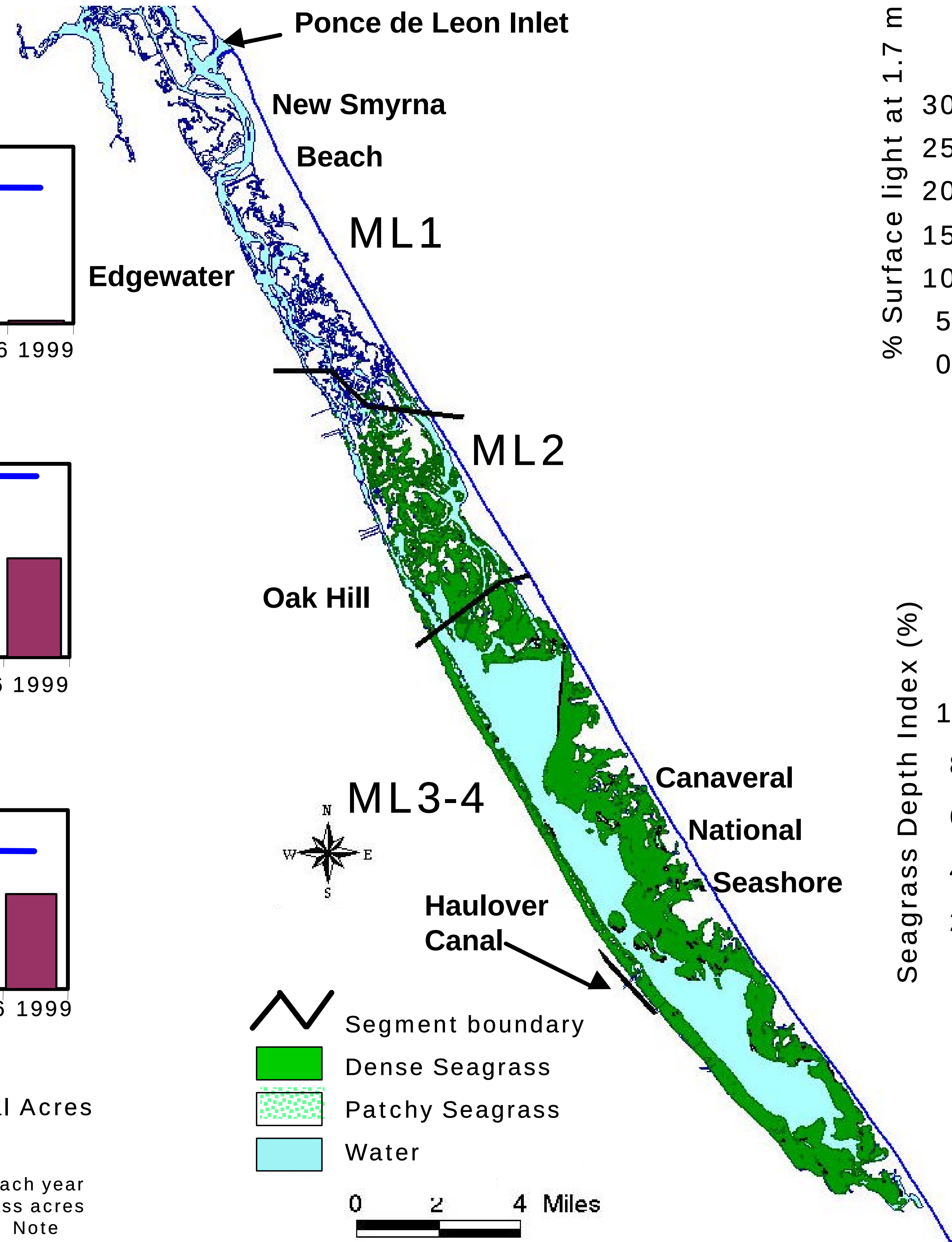



Figure 3-1a. Mosquito Lagoon 1999 seagrass coverage and segment boundaries

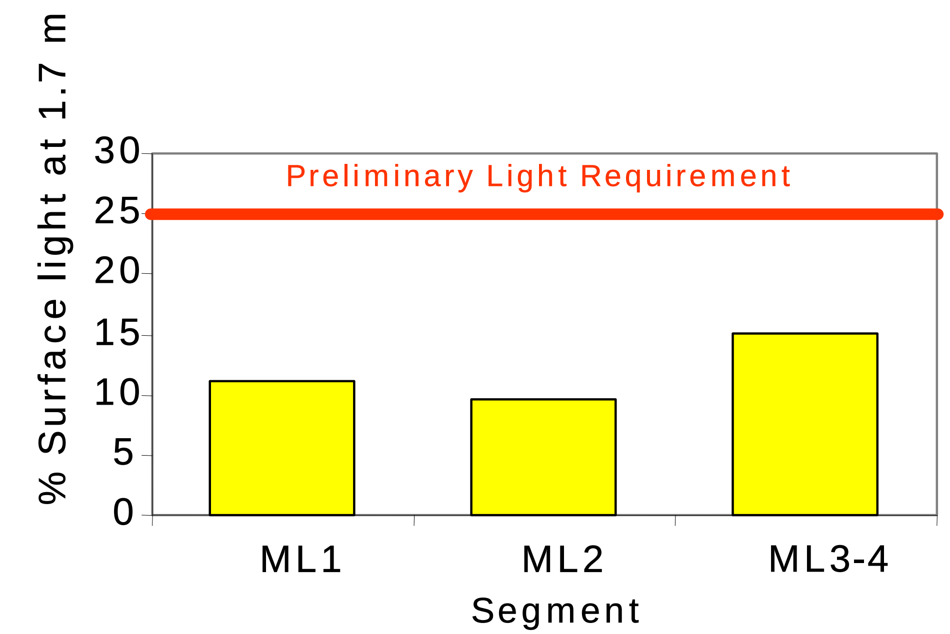



Figure 3-1c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999. Note that even segment ML3-4 is far below the target.

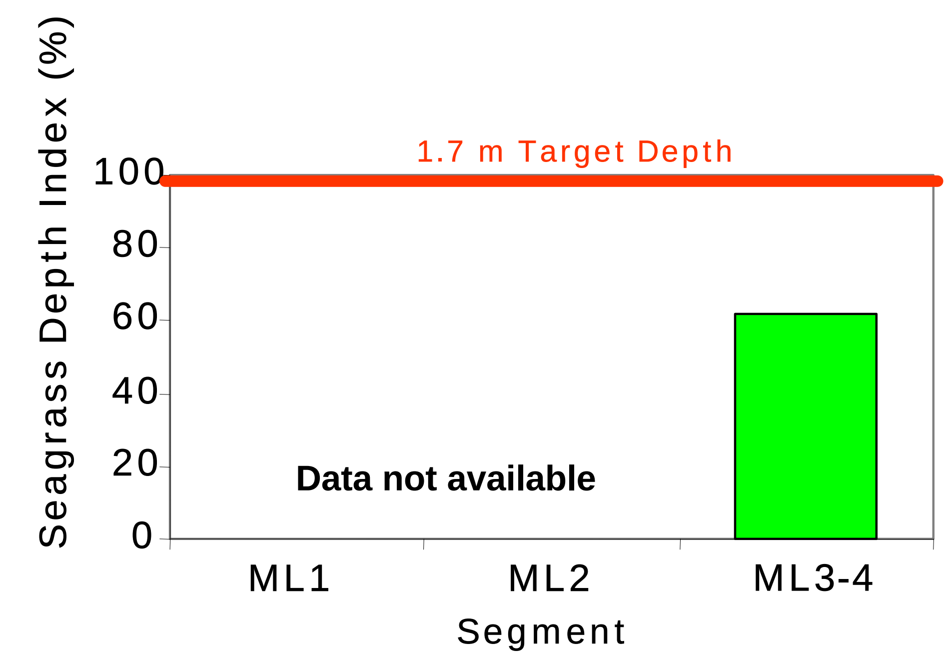



Figure 3-1d. Average Seagrass Depth Index = depth of edge of bed as a percent of 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

**Table 3-1.** General classification of Mosquito Lagoon segments – Good, Fair, or Poor

Classification is based on the following indices or criteria: % surface light @ 1.7 m, seagrass depth index or SDI (a measure of the depth extent of seagrass relative to the target depth of 1.7 m; see Figure 3-1d), and percent loss of seagrass since 1943 (= 50% and = 75%). Any segment receiving 3 or more marks is classified as Poor, 2 marks indicate Fair, and 1 mark or less is Good.

| **Mosquito Lagoon Segments** | = 20% of surface light @ 1.7 m | SDI = 75% | loss since '43 = 50% | loss since '43 = 75% | Classification |
|---|---|---|---|---|---|
| ML1 | X | Insufficient Data | X | X | Poor |
| ML 2 | X | Insufficient Data | | | Fair, possibly Good |
| ML 3-4 | X | X | | | Fair |

So, why does seagrass coverage in southern Mosquito Lagoon remain so extensive and stable? The answer is probably related to its shallowness. Mosquito Lagoon is less than 1.3 m or 4 ft average depth; whereas the other lagoons average 2 to 2.4 m in depth. Mosquito Lagoon's broad shallow flats allow extensive seagrass coverage. Nearly all the seagrass coverage is ≤1.2 m in the southern reach (ML3-4; see Figure 3-1d) and ≤0.3 m in the central reach (ML2). But, this shallow depth, combined with a broad fetch, may lend itself to frequent wind-induced re-suspension of sediment, exacerbating turbid conditions and the attenuation of light. Nonetheless, the amount of light available throughout the expansive shallows is still enough to maintain a large coverage of seagrass.

## ***Water Quality Assessment***

Mosquito Lagoon, along with the South IRL, exhibited the highest 10-year average salinities – 31 to 33 ppt -- of any area in the IRL system (Figure 3-2a). There was also fairly strong temporal stability in salinity in Mosquito Lagoon. The slight decline in salinity that did occur from 1994 to 1996 was probably a response to the more protracted higher rainfall levels during that time (Figure 3-2e). In general, salinity remains consistently high and is not a problem relative to seagrass growth.

Color also increased during 1994 – 1996 (Figure 3-2a); a good indication that the higher rainfall levels induced higher land runoff input to Mosquito lagoon. Furthermore, color has been gradually increasing over the years. That may be a natural response to the general increase in annual rainfall (runoff) since the late 1980s (Figure 3-2e). This trend is noticeable in the southern Mosquito Lagoon (ML3-4), where, since 1996, color levels have been above 20 pcu nearly as often as they have been below that level (Figure 3-2b). The implications of this trend with respect to light limitation may be as important as for other optical pollutants, like turbidity and TSS.

As stated above, turbidity is an important factor limiting light in Mosquito Lagoon. Mosquito Lagoon's 10-year average turbidity is >6 ntu, higher than most other IRL areas. Turbidity appears to be strongly influenced by TSS.

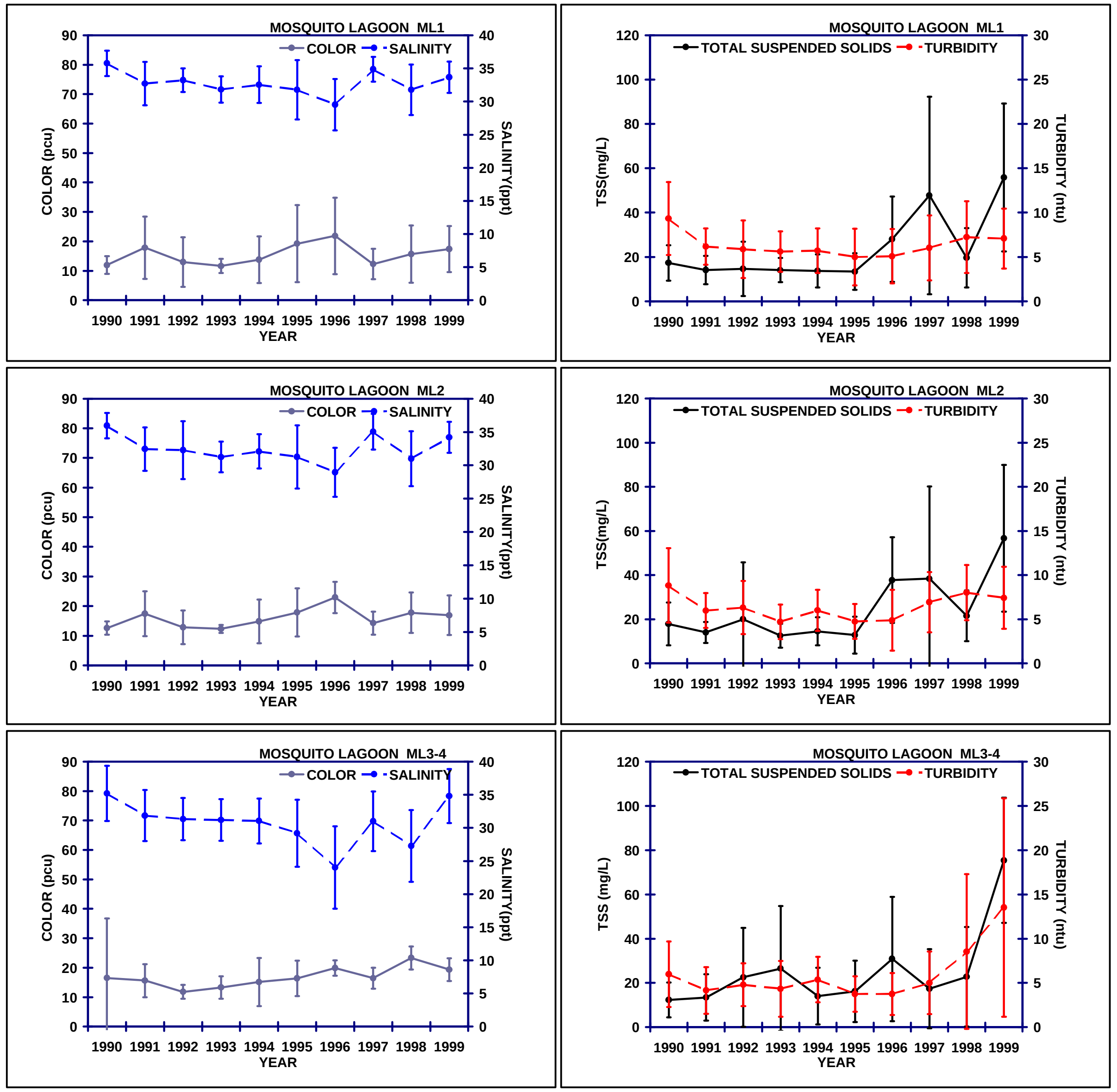



Figure 3-2a. Temporal distribution of color, salinity, TSS and turbidity in the Mosquito Lagoon ($\bar{x}$ ± 1sd, 1990-1999 period of record).

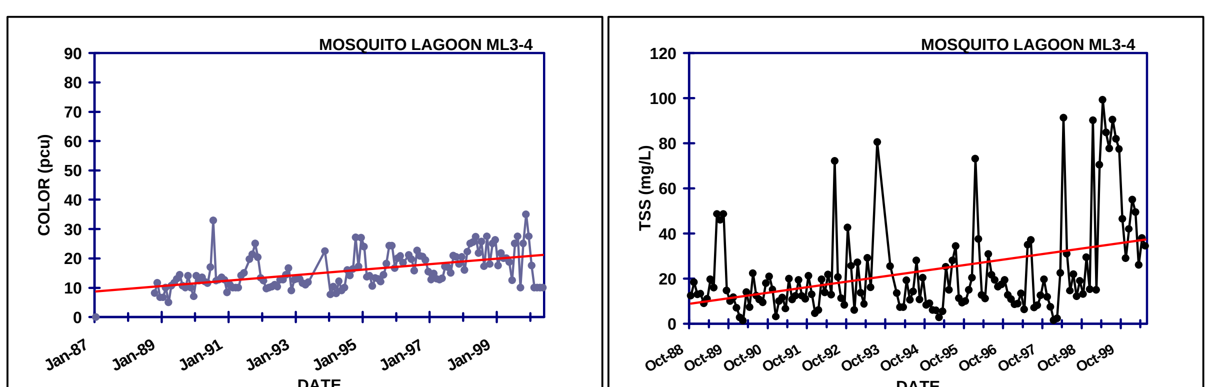
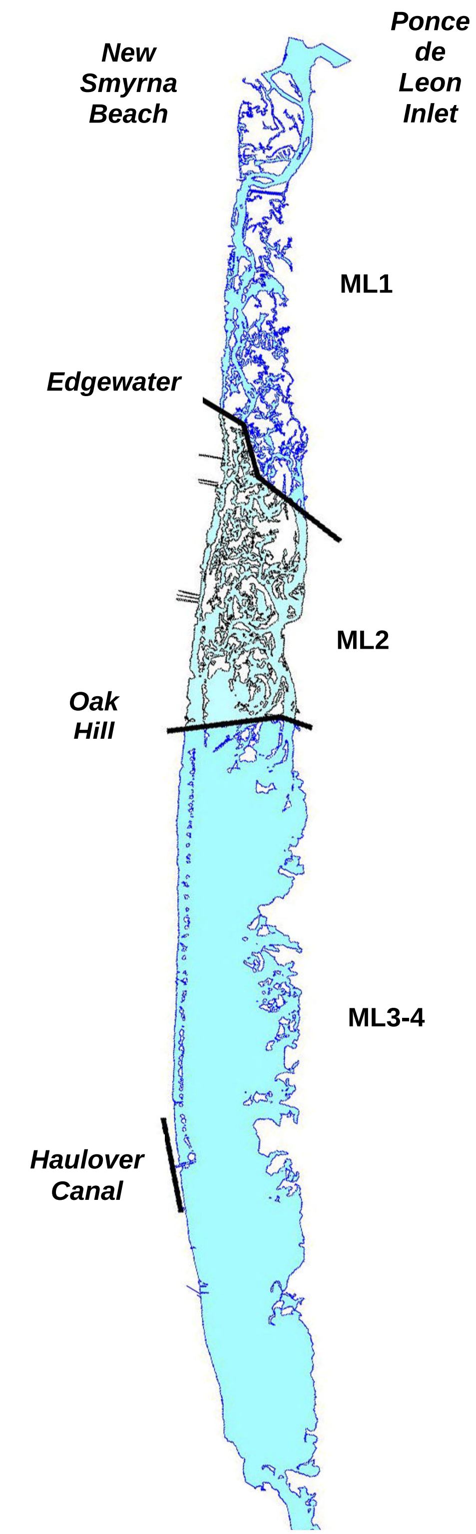



**Figure 3-2b**. Increasing trends in color and TSS in the southern reach of Mosquito Lagoon (monthly data with trendlines).




Mosquito Lagoon
**(Segments ML1 – ML3-4)**

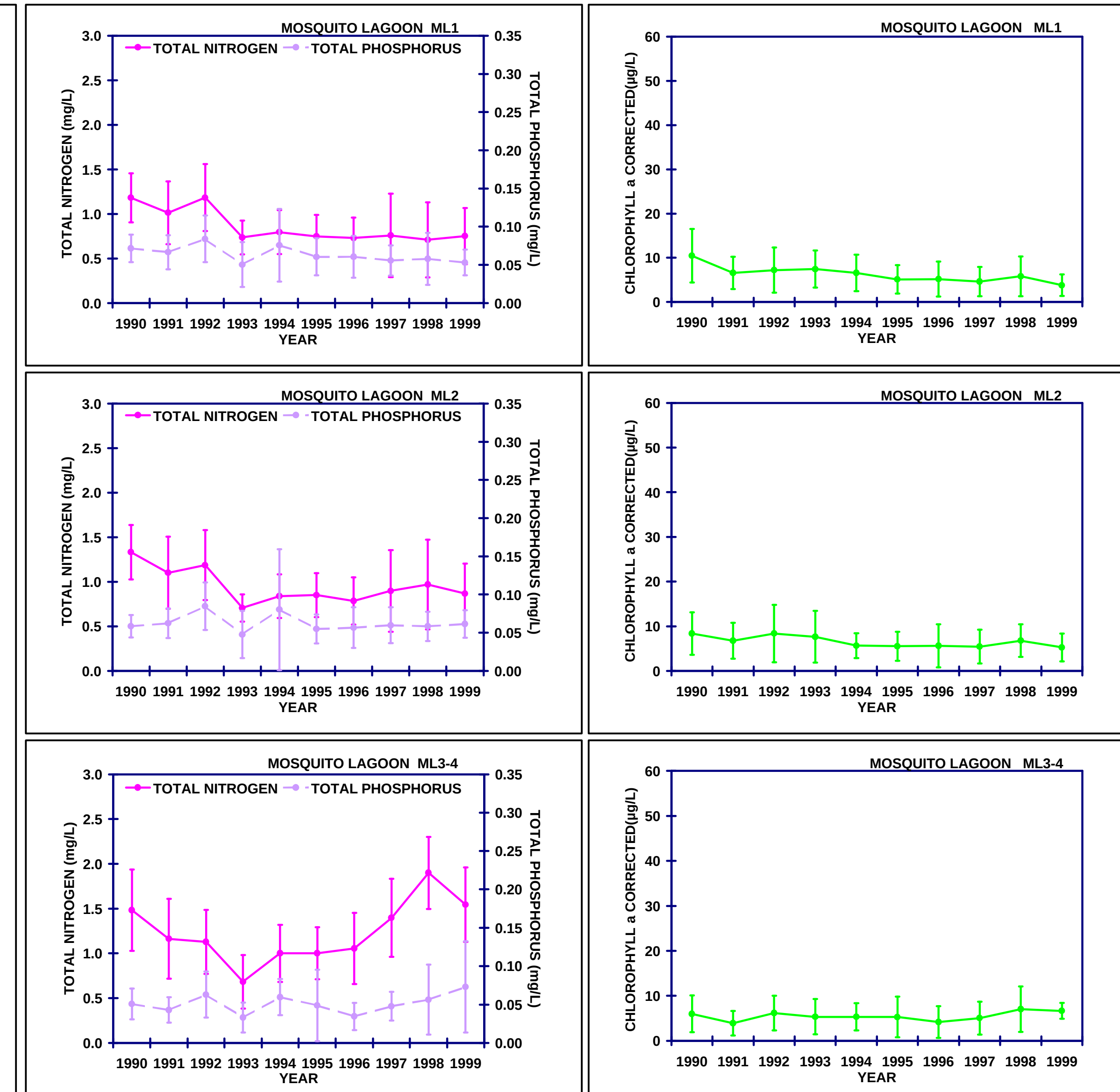



**Figure 3-2c.** Temporal distribution of total nitrogen, total phosphorus and chlorophyll *a* corrected in the Mosquito Lagoon ($\bar{x}$± 1sd, 1990-1999 period of record).

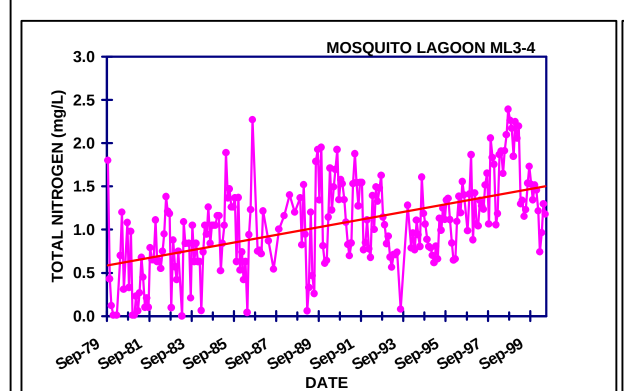



**Figure 3-2d.** Increasing trend in TN in the southern reach of Mosquito Lagoon (monthly data).

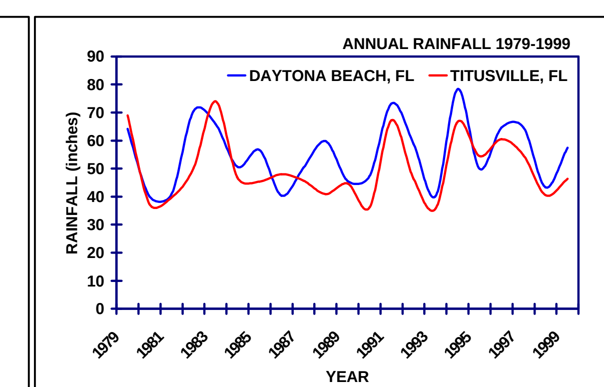



**Figure 3-2e.** Annual Rainfall since 1979 near the Mosquito Lagoon.

If TSS levels in Mosquito Lagoon can be kept low, turbidity should follow suit. Unfortunately, between 1995 and 1999, TSS levels generally increased, as did turbidity (Figure 3-2a). In 1999, the average TSS levels in the Mosquito Lagoon skyrocketed to >50 mg/l, about 3 times pre-1996 levels.

Perhaps as troubling as the increasing TSS trend, is the increase in TN levels in the southern Mosquito Lagoon from 1996 to 1999 (ML3-4) (Figure 3-2c and d). Even so, these TN levels have not promoted a similar phytoplankton (chlorophyll *a*) response. It is fortunate that chlorophyll *a* levels have remained relatively low and stable over the last 10 years (mean annual concentrations are ~5 to 6 µg/l, and below 6.7 µg/l provisional mean annual threshold). Nonetheless, considering that there may be a trend in increasing TN levels and that chlorophyll *a* (phytoplankton) concentration is a light-limiting co-factor with turbidity, better nutrient management in the Mosquito Lagoon basin is warranted[1].

It is possible that nitrogen has always been in abundant supply for phytoplankton growth. Nitrogen was often not the limiting nutrient in Mosquito Lagoon during a study conducted by Phlips et al. (2000). According to that study, phosphorus was revealed to be the "primary limiting nutrient or became limiting after the depletion of surplus nutrients." What that means is that Mosquito Lagoon may be sensitive to elevated inputs of phosphorus, even periodic "pulsed" loadings that would occur during and after storm events. Such an effect may be even more pronounced in developed or developing areas where land-use intensification and phosphorus loading are correlated (Perlstein, 1981). It's possible that chlorophyll *a* levels have remained low, despite elevations in TN, because the majority of TN is organic and less bioavailable than inorganic N and/or there were no increased phosphorus inputs sufficient to trigger higher phytoplankton densities.

## ***Summary of Assessments***

Mosquito Lagoon's shallow depth (average1.3 m or 4 ft) allows expansive coverage of seagrass, but its shallowness can also make it susceptible to elevated turbidities, maybe more susceptible than other IRL areas. Additionally, enrichment of nutrients is a special concern in the southern reach where the residence time may be on the order of 2 to 3 months in contrast to the northern reach where it's less than 1 month. We may now be seeing evidence of water quality decline as demonstrated by increases of TN, TSS, and color from 1995 through 1999. It's difficult to discern whether this is beginning to have a major impact on seagrass or not. But, we need to assume that the threshold of impact is near – the caution flag for Mosquito Lagoon has been raised.

[1] Large accumulations of unattached macroalgae (seaweed) observed in Mosquito Lagoon may also be an indication of excess nutrients, most likely nitrogen.

## ***Progress on Projects***

**Strategies for Pollutant Load Reduction.** It's becoming more evident that improvement in soil retention and nutrient management practices will play a significant role in improving water clarity conditions in the Mosquito Lagoon. Annual average pollutant loads of nutrients and TSS from non-point sources have increased about 1.5 times since 1943 (Figure 3-3). Pollutant loads will continue to increase with development if no further action is taken to ensure retrofit projects and best management practices are permanent fixtures in both the physical and cultural landscapes.

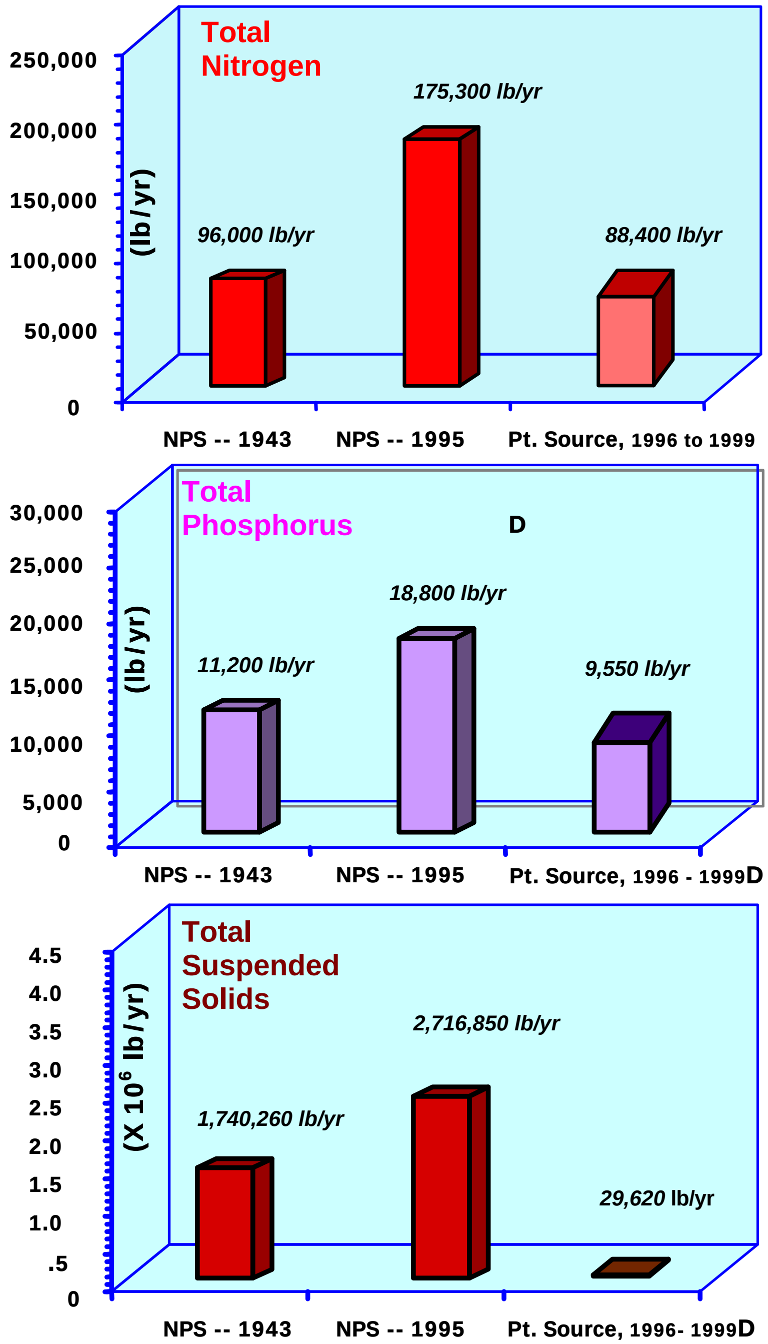



**Figure 3-3.**
**Mosquito Lagoon TN, TP, and TSS loading comparisons:**

- **1943 vs 1995 Non-point source (NPS) run-off loadings**
- **1995 NPS vs annual point source or domestic WWTP loadings.**

**Þ The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.**

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*NPS loadings estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

The District, along with state and federal partners, and local governments -- Volusia County, New Smyrna Beach (and adjacent barrier island communities), Edgewater, and Oak Hill – must re-vitalize or strengthen cooperative efforts toward that end.

*Non-Point Source Strategy -- Stormwater.* Volume reduction and treatment of surface water drainage, particularly urban runoff, are the major elements of the non-point source campaign in Mosquito Lagoon. Since the early 1990s, this campaign has focused on urban projects, primarily in New Smyrna Beach and its adjacent residential/commercial sub-divisions (refer to 1994 IRL SWIM Plan, Table 7, p. 49). More recent projects in New Smyrna Beach include:

- baffle box installation at intersection of Riverside and Wayne avenues in 1997/98; serving 15 acres of mostly commercial land use
- development of a plan to upgrade the drainage system along Riverside and Magnolia avenues serving 52 acres (construction of catch basins, exfiltration systems, etc.).

*Non-Point Source Strategy – Muck.* A muck sediment survey conducted in 1989 (Trefry et al., 1990) found no major deposits between New Smyrna Beach and Oak Hill. Three minor deposits were discovered south of Oak Hill in the Intracoastal Waterway (ICW). It is believed that those deposits may be a result of the transport of soil and organic material from the more developed northern and central reaches, and from a nearby drainage canal. Overall, very little muck sediment was found in Mosquito Lagoon during the 1989 survey and, consequently, was not considered to be an important loading source of nutrients to this estuary.

It is anticipated that the U.S. Army Corps of Engineers will eventually dredge the muck material from the ICW as part of its channel maintenance program. According to a statement made by the Florida Inland Navigation District, the dredging of the ICW in Mosquito Lagoon may begin no earlier than 2006 (Canaveral National Seashore Water Resources Management Plan, 2001).

*Non-Point Source Strategy – Septic Tanks.* Volusia County and the basin's mainland communities should renew efforts to expand centralized wastewater treatment service into areas served by septic tanks or OSDS (on-site disposal systems). In the mid-1990s, the county and New Smyrna Beach were successful in expanding sewer service to the barrier island communities that stretch from Ponce de Leon Inlet to Canaveral National Seashore. This action followed County reports that OSDS on the western side of Rt. A1A were likely contributors of nitrogen and pathogen loads to Mosquito Lagoon. Another report developed by Volusia County and SJRWMD to comply with the IRL "No Discharge" Protection Act (Chapter 90-262, Laws of Florida) found that the potential for OSDS contamination by certain mainland areas is high and those areas should also be considered for "hook-up" as soon as a centralized sewer service is available (Bielby, 1993).

*Point Source Strategy – Domestic Wastewater Treatment Plants*. By 1996, most of the major domestic wastewater treatment plants (WWTP) in the IRL system fully complied with the IRL "No Discharge" Protection Act. The State of Florida temporarily exempted the New Smyrna Beach and Edgewater WWTPS, allowing these facilities to continue discharging to Mosquito Lagoon[2] until they could implement the necessary treatment system upgrades and reuse plans.

[2] The New Smyrna and Edgewater plants are regulated by FDEP under "water quality-based effluent limitations" or WQBELs and the Florida APRICOT Act.

During the latter half of the 1990s, these two WWTPS discharged a combined annual loading of 88,400 lb of TN, 9,550 lb of TP, and 29,620 lb of TSS (Figure 3-3); which represented, respectively, 39%, 34% and 1% of the estimated total surface water loads to Mosquito Lagoon. However, substantial reductions in these point source loads will be realized over the next few years.

A new advanced WWTP for New Smyrna Beach was recently constructed and will eventually include a large capacity reuse system (6 MGD, nearly 100% of total design capacity). Wet weather (back-up) discharge is allowed, but large reductions in effluent discharge to the lagoon are expected.

The City of Edgewater is presently securing funds to construct a 2.25 million gallon storage tank to contain treated or reclaimed water during wet weather. This water can then be re-used for lawn irrigation during dry conditions[3]. The effect of this reuse is a targeted 34% reduction in annual effluent discharge volume to the Mosquito Lagoon. Eventually the Edgewater plant may have the capability to increase its reuse capacity and, thus, decrease effluent discharge even further.

As monitoring continues and PLRGs are developed, point and non-point source assessments will reveal whether additional pollutant load reductions from either or both sources are necessary.

**Monitoring, Modeling, and Applied Studies.** The SJRWMD, Volusia County, NASA, and other participating agencies will continue the seagrass and water quality monitoring networks described in Chapter 2 (pp. 2-15 and 2-16). The SJRWMD will also evaluate and refine the monitoring networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Analyses and biennial reporting of monitoring data will key in on those major optical pollutants that are significant in the Mosquito Lagoon; with special attention paid to TSS and nutrients. A re-survey of muck sediments and a reconnaissance of major upland sources of TSS and TN are recommended[4].

The SJRWMD may further investigate possible causes for the dramatic seagrass loss in northern Mosquito Lagoon (ML1). It seems that there may be other factors involved in this area besides those related to light limitation (e.g., hydrodynamics, lack of suitable substrate).

The Pollutant Load Reduction (PLR) Model is scheduled for completion at the end of 2002. That will be followed by the application of the model in the development of recommended *final* PLRGs for Mosquito Lagoon by end of 2004. In the meantime, provisional pollutant load reduction targets based on estimated, c. 1943 loading rates (i.e., provisional “allowable” or desirable loading rates) can be used in stormwater treatment designs. These provisional targets are intended to be conservative and, thus, be used to design municipal or regional stormwater treatment systems that should be able to meet final PLRGs. It is assumed that by meeting c. 1943 loading rates, water

[3] The SJRWMD is contributing $202,000 toward this project; Edgewater $141,815 (total cost = $343,815)

[4] In addition, Lagoon-wide investigations in sediment particle re-suspension and the optical properties of various types of suspended material may provide major clues as to what type of suspended material most influences turbidity and light penetration. That knowledge may be important in targeting tighter controls on very specific sources of TSS.